



(11) **EP 1 108 599 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**20.06.2001 Bulletin 2001/25**

(51) Int Cl.7: **B60K 15/03**

(21) Application number: **00204628.2**

(22) Date of filing: **18.12.2000**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU**  
**MC NL PT SE TR**  
 Designated Extension States:  
**AL LT LV MK RO SI**

(30) Priority: **18.12.1999 US 172567 P**

(71) Applicant: **Delphi Technologies, Inc.**  
**Troy, MI 48007 (US)**

(72) Inventor: **Ellis, Thomas S.**  
**Romeo, MI 48065 (US)**

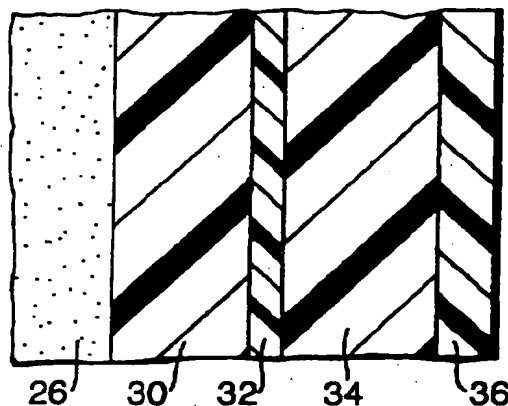
(74) Representative: **Denton, Michael John et al**  
**Delphi Automotive Systems**  
**Centre Technique Paris**  
**117 avenue des Nations**  
**B.P. 60059**  
**95972 Roissy Charles de Gaulle Cedex (FR)**

(54) **Permeation barrier fuel tank**

(57) A permeation barrier fuel tank (10) for a vehicle includes a tank shell (12) having a wall formed from a plurality of layers (30,32,34,36). The layers (30,32,34,36) include at least an inner layer (30), an out-

er layer (34), a fuel permeation barrier layer (32) disposed between the inner layer (30) and the outer layer (34) and a nanocomposite outer layer (36) disposed adjacent to the outer layer (34).

**Fig.2.**



## Description

### TECHNICAL FIELD

[0001] The present invention relates generally to fuel tanks for vehicles and, more particularly, to a permeation barrier fuel tank for a vehicle.

### BACKGROUND OF THE INVENTION

[0002] It is known to provide a fuel tank such as a plastic fuel tank in a vehicle to hold fuel to be used by an engine of the vehicle. In some vehicles, the plastic fuel tank is made from polymers that are typically multi-layer structures in which one or more barrier polymer layers are introduced to prevent unacceptable loss of fuel to atmosphere because of permeation through walls of the fuel tank. For example, a fuel tank may be composed of high-density polyethylene (HDPE) in which a layer of a barrier polymer, such as a polyamide or an ethylene-vinyl alcohol copolymer has been fabricated.

[0003] Fuel tanks made by either blow molding or other thermoforming methods will possess a seam where the barrier layer is extremely thin or sometimes the barrier layer is incomplete. In these areas, there is a significant increase in fuel permeation to the atmosphere.

[0004] One commercial approach to resolve this concern regarding permeation is to thicken the walls of the fuel tank, which increases the weight, cost and reduces fuel capacity of the fuel tank. Another commercial approach is to add metal sheets or shields to the fuel tank, which increases the weight and cost of the plastic fuel tank.

[0005] Therefore, it is desirable to provide a fuel tank for a vehicle that has a more effective fuel permeation barrier to prevent evaporative emissions. It is also desirable to provide a permeation barrier fuel tank for a vehicle that significantly reduces evaporative emissions, weight and cost of the fuel tank.

### SUMMARY OF THE INVENTION

[0006] It is, therefore, one object of the present invention to provide a new permeation barrier fuel tank for a vehicle.

[0007] It is another object of the present invention to provide a fuel tank that significantly reduces evaporative emissions without unduly increasing weight and cost.

[0008] To achieve the foregoing objects, the present invention is a fuel permeation barrier fuel tank for a vehicle including a tank shell having a wall formed from a plurality of layers. The layers include at least an inner layer, an outer layer, a fuel permeation barrier layer disposed between the inner layer and the outer layer and a nanocomposite layer disposed adjacent to the outer layer.

[0009] One advantage of the present invention is that a permeation barrier fuel tank is provided for a vehicle

that has improved performance in reducing volatile fuel component emissions into the atmosphere from a seam or "pinch off" areas of the fuel tank. Another advantage of the present invention is that the permeation barrier fuel tank incorporates a nanocomposite polymer outer layer, resulting in cost savings of the fuel tank. Yet another advantage of the present invention is that the permeation barrier fuel tank significantly improves performance by reducing volatile fuel emissions into the atmosphere from a body of the fuel tank. Still another advantage of the present invention is that the permeation barrier fuel tank has improved resistance to burning in the event of an external fire using a non-halogenated material. A further advantage of the present invention is that the permeation barrier fuel tank can still be manufactured using existing thermoforming processes.

[0010] Other objects, features and advantages of the present invention will be readily appreciated, as the same becomes better understood, after reading the subsequent description taken in conjunction with the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Figure 1 is a perspective view of a permeation barrier fuel tank, according to the present invention.

[0012] Figure 2 is a sectional view taken along line 2-2 of Figure 1.

[0013] Figure 3 is a fragmentary elevational view of a pinch off area of the permeation barrier fuel tank of Figure 1.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

[0014] Referring to the drawings and in particular Figures 1 and 2, one embodiment of a permeation barrier fuel tank 10, according to the present invention, is shown for a vehicle (not shown). The permeation barrier fuel tank 10 includes a tank shell 12. In the embodiment illustrated, the tank shell 12 is of a generally rectangular type. The tank shell 12 includes a first or lower half shell 14 and a second or upper half shell 16. The lower half shell 14 has a base wall 18 and a side wall 20 around a periphery of the base wall 18 and extending generally perpendicular thereto. The side wall 20 has a flange 22 extending outwardly and generally perpendicular thereto. The upper half shell 16 has a base wall 24 and a side wall 26 around a periphery of the base wall 24 and extending generally perpendicular thereto. The side wall 26 has a flange 28 extending outwardly and generally perpendicular thereto. The flanges 22 and 28 of the lower half shell 14 and upper half shell 16, respectively, are joined together to form a seam by suitable means such as by thermoforming, compression molding or friction welding. The lower half shell 14 and upper half shell 16 are made of a rigid material such as a thermoformable plastic.

[0015] Referring to Figures 1 and 2, the permeation

barrier fuel tank 10 has the base walls 18,24, side walls 20,26, and flanges 22,28 formed from a plurality of layers 30,32,34,36. The first or inner layer 30 is made from a thermoformable polymer such as a high density polyethylene (HDPE) or similar polyolefin, which is a conventional material known in the art. The inner layer 30 has a predetermined thickness of approximately two millimeters (2.00 mm).

[0016] The second or fuel permeation barrier layer 32 is made from a barrier polymer as a barrier layer between the inner layer 30 and an outer layer 34 to be described. The barrier polymer is a polymer material such as a polyamide or an ethylene-vinyl alcohol (EVOH) copolymer which is a conventional material known in the art. The fuel permeation barrier layer 32 has a predetermined thickness of approximately 0.1 mm to approximately 1.0 mm.

[0017] The third or outer layer 34 is made from a thermoformable polymer such as a high density polyethylene (HDPE) or similar polyolefin, which is a conventional material known in the art. The outer layer 34 has a predetermined thickness of approximately two millimeters (2.00 mm).

[0018] The fourth or nanocomposite outer layer 36 is made from a nanocomposite polymer as a barrier layer adjacent the outer layer 34. The nanocomposite polymer is a polymer material such as high density polyethylene (HDPE) in which a small quantity from about 0 wt. % to about 15 wt.% of a platy filler material has been uniformly dispersed. The platy filler material has particles with a high aspect ratio of about two hundred (200) to about one thousand (1000) where the thickness is of the order of one nanometer (1 nm). The nanocomposite outer layer 36 is about 0% to about 15% of the total thickness of the layers.

[0019] In manufacturing the permeation barrier fuel tank 10, several conventional processes such as extrusion, lamination, etc., may be used. Preferably, the permeation barrier fuel tank 10 is formed by a conventional thermoforming process wherein the nanocomposite outer layer 36 can be thermoformed along with the outer layer 34 by heat and pressure. The presence of the platy filler material presents an efficient obstacle to the transport, i.e. diffusion, of penetrant molecules, such as those normally found in fuels. It should be appreciated that the incorporation of a polymer nanocomposite as the external layer for the nanocomposite outer layer 36 in a fuel tank provides a significant improvement in preventing permeation of fuel to the atmosphere. It should also be appreciated that nanocomposite polymer of the nanocomposite outer layer 36 provides an effective barrier to permeation both in the body of the fuel tank and in the seam or "pinch off" areas as illustrated in Figure 3. It should further be appreciated that the nanocomposite polymer provides improved flame resistance over conventional unfilled polymers.

[0020] The present invention has been described in an illustrative manner. It is to be understood that the ter-

minology, which has been used, is intended to be in the nature of words of description rather than of limitation.

[0021] Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.

## 10 Claims

1. A permeation barrier fuel tank (10) for a vehicle comprising:

a tank shell (12) having a wall formed from a plurality of layers (30,32,34,36);  
said layers (30,32,34,36) comprising at least an inner layer (30), an outer layer (34), a fuel permeation barrier layer (32) disposed between said inner layer (30) and said outer layer (34), and a nanocomposite outer layer (36) disposed adjacent to said outer layer (34).

2. A permeation barrier fuel tank (10) as set forth in claim 1 wherein said nanocomposite outer layer (36) is made of a nanocomposite polymer.

3. A permeation barrier fuel tank (10) as set forth in claim 1 wherein said inner layer (30) and said outer layer (34) are made of a polyethylene material.

4. A permeation barrier fuel tank (10) as set forth in claim 2 wherein said nanocomposite polymer comprises a polymer material including a predetermined amount of a platy filler material.

5. A permeation barrier fuel tank (10) as set forth in claim 4 wherein said platy filler material is uniformly dispersed in said polymer material.

6. A permeation barrier fuel tank (10) as set forth in claim 4 wherein said platy filler material is present in an amount from about 0 wt.% to about 15 wt.%.

7. A permeation barrier fuel tank (10) as set forth in claim 4 wherein said platy filler material has an aspect ratio from about 200 to about 1000.

8. A permeation barrier fuel tank (10) as set forth in claim 1 wherein said nanocomposite outer layer (36) has a thickness of about fifteen percent of a total thickness of said layers (30,32,34,36).

9. A permeation barrier fuel tank (10) as set forth in claim 1 wherein said fuel permeation barrier layer (32) is made of either one of a polyamide or an ethylene-vinyl alcohol copolymer.

10. A permeation barrier fuel tank (10) for a vehicle comprising:

a tank shell (12) having a wall formed from a plurality of layers (30,32,34,36);  
said layers (30,32,34,36) comprising at least an inner layer (30) and an outer layer (34);  
a fuel permeation barrier layer (32) disposed between said inner layer (30) and said outer layer (34); and  
a nanocomposite outer layer (36) disposed adjacent to said outer layer (34) and being made of a nanocomposite polymer.

5

10

11. A permeation barrier fuel tank (10) as set forth in claim 10 wherein said inner layer (30) and said outer layer (34) are made of a polyethylene material.

15

12. A permeation barrier fuel tank (10) as set forth in claim 10 wherein said nanocomposite polymer comprises a polymer material including a predetermined amount of a platy filler material.

20

13. A permeation barrier fuel tank (10) as set forth in claim 12 wherein said platy filler material is uniformly dispersed in said polymer material.

25

14. A permeation barrier fuel tank (10) as set forth in claim 12 wherein said platy filler material is present in an amount from about 0 wt.% to about 15 wt.%.

30

15. A permeation barrier fuel tank (10) as set forth in claim 12 wherein said platy filler material has an aspect ratio from about 200 to about 1000.

35

16. A permeation barrier fuel tank (10) as set forth in claim 10 wherein said nanocomposite outer layer (36) has a thickness of about fifteen percent of a total thickness of said layers (30,32,34,36).

40

17. A permeation barrier fuel tank (10) as set forth in claim 10 wherein said inner layer (30) and said outer layer (34) are made of a high density polyethylene.

18. A permeation barrier fuel tank (10) as set forth in claim 10 wherein said fuel permeation barrier layer (32) is made of either one of a polyamide or an ethylene-vinyl alcohol copolymer.

45

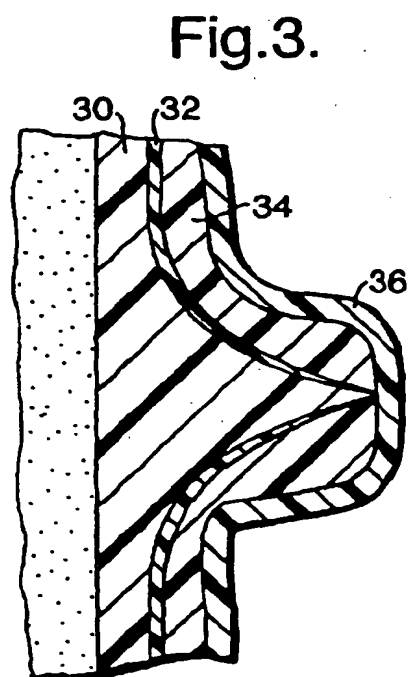
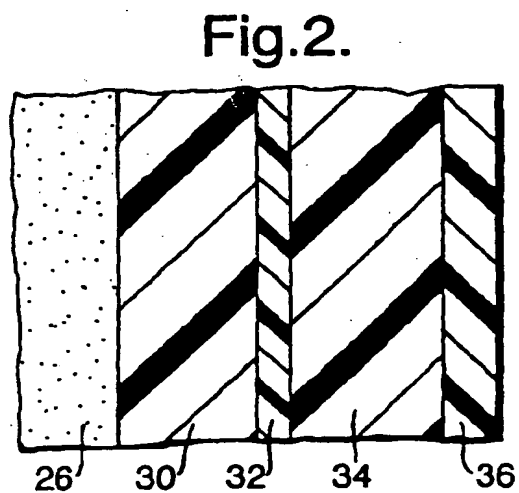
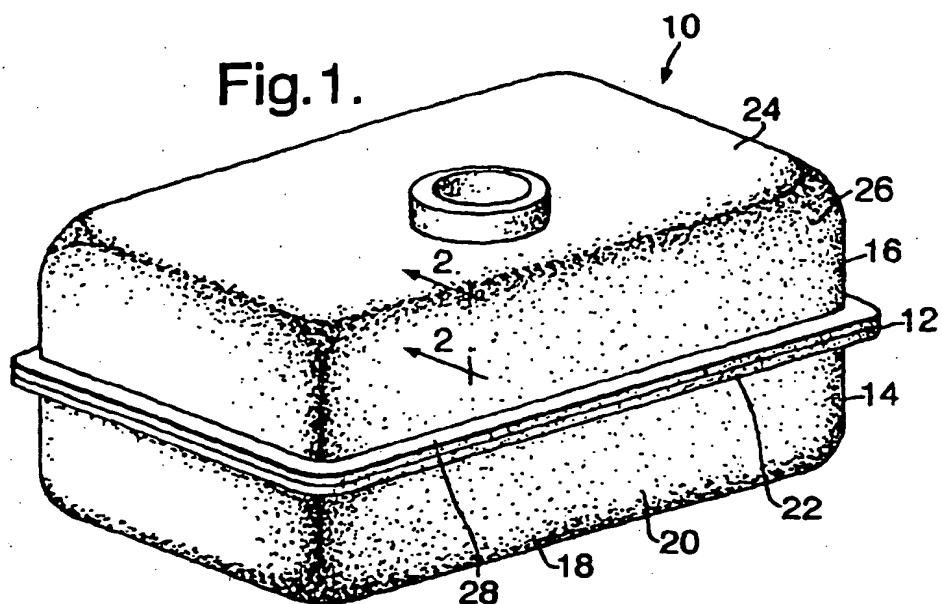
19. A fuel tank (10) for a vehicle comprising:

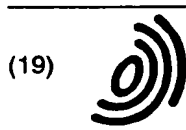
50

a tank shell (12) having a wall formed from a plurality of layers (30,32,34,36);  
said layers (30,32,34,36) comprising at least an inner layer (30) and an outer layer (34) comprising a polyethylene material;  
a fuel permeation barrier layer (32) disposed between said inner layer (30) and said outer

55

layer (34); and  
a nanocomposite outer layer (36) disposed adjacent to said outer layer (34) and being made of a nanocomposite polymer comprising a polymer material including a predetermined amount of a platy filler material having a thickness of about one nanometer.





Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) **EP 1 108 599 A3**

(12) **EUROPEAN PATENT APPLICATION**

(88) Date of publication A3:  
15.10.2003 Bulletin 2003/42

(51) Int Cl.7: **B60K 15/03, B32B 27/08**

(43) Date of publication A2:  
20.06.2001 Bulletin 2001/25

(21) Application number: **00204628.2**

(22) Date of filing: **18.12.2000**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE TR**  
Designated Extension States:  
**AL LT LV MK RO SI**

(72) Inventor: **Ellis, Thomas S.**  
**Romeo, MI 48065 (US)**

(74) Representative: **Denton, Michael John et al**  
**Delphi Automotive Systems,**  
**Centre Technique Paris,**  
**117, avenue des Nations,**  
**B.P. 60059**  
**95972 Roissy Charles de Gaulle Cédex (FR)**

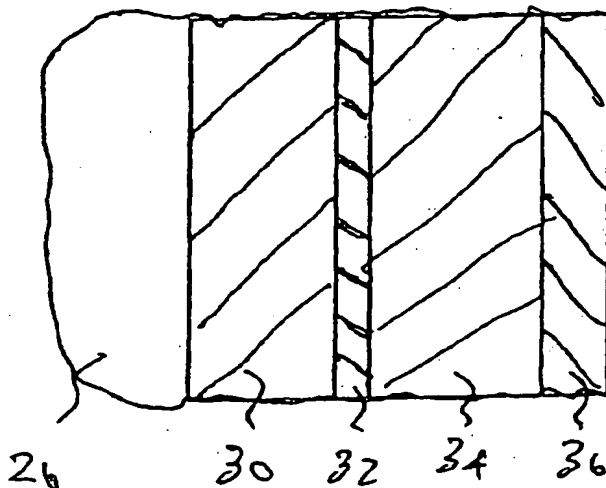
(30) Priority: **18.12.1999 US 172567 P**

(71) Applicant: **Delphi Technologies, Inc.**  
**Troy, MI 48007 (US)**

(54) **Permeation barrier fuel tank**

(57) A permeation barrier fuel tank (10) for a vehicle includes a tank shell (12) having a wall formed from a plurality of layers (30,32,34,36). The layers (30,32,34,36) include at least an inner layer (30), an out-

er layer (34), a fuel permeation barrier layer (32) disposed between the inner layer (30) and the outer layer (34) and a nanocomposite outer layer (36) disposed adjacent to the outer layer (34).



**Figure - 2**



European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
EP 00 20 4628

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (In I.C.I.7)
A	DE 43 37 491 A (KAUTEX WERKE GMBH) 4 May 1995 (1995-05-04) * the whole document *	1,10,19	B60K15/03 B32B27/08
A	WO 98 01346 A (LAURENT JACQUES ;TETRA LAVAL HOLDINGS & FINANCE (CH); FRISK PETER) 15 January 1998 (1998-01-15) * abstract *	1,10,19	
			TECHNICAL FIELDS SEARCHED (In I.C.I.7)
			B32B B60K B29C
The present search report has been drawn up for all claims.			
Place of search BERLIN		Date of completion of the search 11 August 2003	Examiner Tamme, H-M
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons S : member of the same patent family, corresponding document</p>			

EPO FORM 1503 (3-92) (P01C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 20 4628

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-08-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4337491 A	04-05-1995	DE 4337491 A1	04-05-1995
		WO 9512484 A1	11-05-1995
		DE 59407968 D1	22-04-1999
		EP 0679121 A1	02-11-1995
WO 9801346 A	15-01-1998	US 5876812 A	02-03-1999
		US 5916685 A	29-06-1999
		AU 3795097 A	02-02-1998
		EP 0932497 A2	04-08-1999
		JP 2001505165 T	17-04-2001
		WO 9801346 A2	15-01-1998
		US 5972448 A	26-10-1999
		US 6265038 B1	24-07-2001

EPO FORM P4439

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82